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(71) Applicant *(for all designated States except US)*: **NOKIA NETWORKS OY** [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **RAITOLA, Mika** [FI/FI]; Nissnikuntie 7 B 5, FIN-02430 Masala (FI).

(74) Agents: **PELLMANN, Hans-Bernd** et al.; Tiedtke-Bühling-Kinne et al., Bavariaring 4, D-80336 München (DE).

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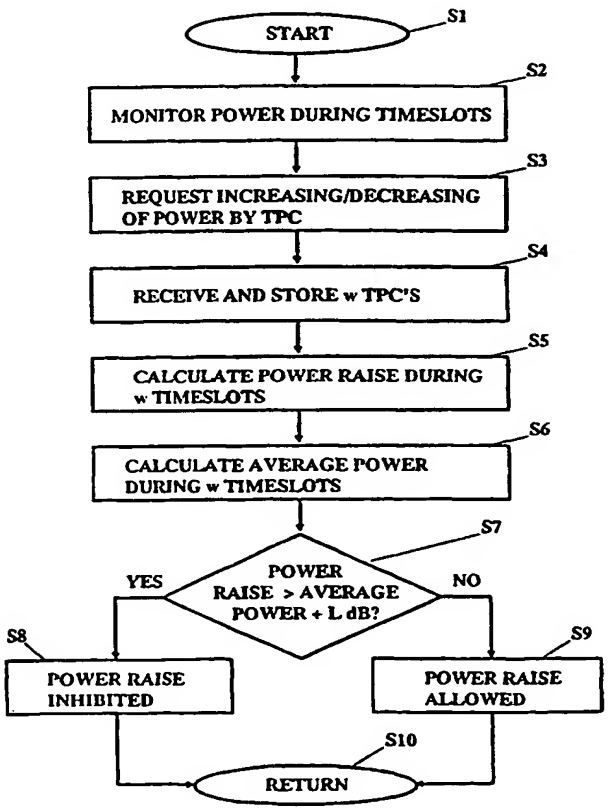
(54) Title: POWER CONTROL METHOD AND DEVICE



(57) Abstract: The present invention proposes a method for controlling a power used for transmitting data between a terminal device (TD) and a transceiver device (BTS) of a communication system, said method comprising the steps of monitoring (S2) during a predetermined time unit the power used in a transmission between said terminal device (TD) and said transceiver device (BTS), requesting (S3) an increase or a decrease of the power used in the transmission by using a specific information element (TPC) for each predetermined time unit, storing (S4) a predetermined number (w) of said specific information elements (TPC), calculating (S5, S6) a first value and a second value concerning the power of transmission during said predetermined number (w) of said specific information elements (TPC), and deciding (S7) by using the first value and the second value concerning the power calculated in said calculating step (S5, S6), whether the first value concerning the power is greater than a sum of the second value concerning the power and a predetermined level (L). The present invention also proposes a corresponding device.

WO 01/03328 A1

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POWER CONTROL METHOD AND DEVICE

FIELD OF THE INVENTION

The present invention relates to a method for controlling a power used for transmitting data between a terminal device and a transceiver device of a communication system and also to a corresponding device. In particular, the present invention is directed to a power control method and corresponding device used in Code Division Multiple Access (CDMA) systems.

BACKGROUND OF THE INVENTION

In recent years, mobile radio telecommunication systems have widely spread. Such mobile radio telecommunication systems (for example GSM, 3rd generation system such as the Universal Mobile Telecommunications System (UMTS) and others) operate with different data transmission methods. Such a data transmission method is for example a Code Division Multiple Access (CDMA) method. Said CDMA method is further developed into a Wideband Code Division Multiple Access (WCDMA) method (or Broadband CDMA) using a greater frequency band for example to be used in 3rd generation communication systems like the UMTS.

In both CDMA and WCDMA methods, the basic operating principle is similar. Data to be transmitted between terminal devices such as mobile stations via a communication network comprising several network elements such as transceiver devices such as base transceiver stations, mobile switching centers and the like is multiplied with a unique code allocated to each connection. Said code has a higher frequency than the data which results in a wide transmission bandwidth in comparison with

the original data bandwidth. This process is also known as spreading.

On a receiving side knowing the respective code, the transmitted signal is decoded and the recovered data is processed further. This process is also known as despreading.

For a correct recovery of the data from the transmitted signal a major condition is that the received signals have a (nearly) constant and equal strength. Since in a mobile telecommunication system, for example due to a movement of the terminal devices, widely different signal strengths may be received when transmitting always with the same transmission power, interference between different terminal devices transmitting at the same time may occur. Therefore, an accurate power control in uplink (terminal device to transceiver station) and downlink (transceiver station to terminal device) is required.

In third generation CDMA systems (e.g. cdma2000, WCDMA) fast power control is used both in uplink and downlink. Here, the decoding performance is optimal when the received signal power is as constant as possible. This is required especially when the service delay is limited (for example in speech communication) and a fading may cause errors. The fast power control is able to follow even fast fadings.

On the other hand, the downlink transmission capacity is maximized when the transmitted power is minimized, i.e. the generated interference is as low as possible. However, fast power control aims that the received power is constant. This means that the transmitted power varies greatly, which increases the transmitted power average. Also, the variation of transmitted power causes power spikes which are harmful for system load control.

However, in case of e.g. a packet data service, a retransmission protocol is included. This means that a loss of data, for example due to decoding problems, would not cause absolute errors but only lead to a retransmission. This allows a packet data power control not to follow every fade, but to compensate fades by retransmissions.

When using a slower power control occurrence of high interference spikes as in the fast power control can be prevented. However, slower power control works poorly for delay limited services as it can not follow fast fading of the signal.

SUMMARY OF THE INVENTION

Consequently, it is an object of the present invention to provide a method and a corresponding device for controlling a power used for transmitting data between a terminal device and a transceiver device of a communication system.

According to the present invention, this object is achieved by a method for controlling a power used for transmitting data between a terminal device and a transceiver device of a communication system, said method comprising the steps of monitoring during a predetermined time unit the power used in a transmission between said terminal device and said transceiver device, requesting an increase or a decrease of the power used in the transmission by using a specific information element for each predetermined time unit, storing a predetermined number of said specific information elements, calculating a first value and a second value concerning the power of transmission during said predetermined number of said specific information elements, and deciding by using the first value and the second value concerning the power calculated in said calculating step,

whether the first value concerning the power is greater than a sum of the second value concerning the power and a predetermined level.

Furthermore, the present invention proposes a device for controlling a power used for transmitting data between a terminal device and a transceiver device of a communication system, said device comprising monitoring means for monitoring during a predetermined time unit the power used in a transmission between said terminal device and said transceiver device, requesting means for requesting an increase or a decrease of the power used in the transmission by using a specific information element for each predetermined time unit, storing means for storing a predetermined number of said specific information elements, calculating means for calculating a first value and a second value concerning the power of transmission during said predetermined number of said specific information elements, and deciding means for deciding by using the first value and the second value concerning the power calculated by said calculating means, whether the first value concerning the power is greater than a sum of the second value concerning the power and a predetermined level.

Advantageous further developments of the present invention are as set out in the respective dependent claims.

According to the present invention, the proposed method and/or device are easy to implement since only small changes to present systems are necessary.

Furthermore, for example a downlink power control according to the present invention is able to maximize the decoding performance by following fading as well as possible and also to minimize the interference caused to the other

terminal devices. It is possible to follow even fast fading as in the fast power control, but if the requested power raise within a predetermined time is to high a corresponding high increase of the transmission power is prevented. Moreover, excessively high power spikes are inhibited and therefore the performance of the system load control can be improved.

Preferred embodiments of the invention are described herein below in detail by way of example with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a flowchart illustrating the method according to the present invention.

FIG. 2 shows a block circuit diagram illustrating an embodiment of the device according to the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

In the following, as a first example, the above mentioned downlink case is described.

With reference to FIG. 1, a power control method according to the present invention is illustrated in the flowchart.

In step S1, the power control is started, for example when a packet data communication connection is established between two terminal devices TD via a communication network (i.e. via at least one base transceiver station BTS). During the communication, the signal strength (i.e. the transmission power) from the base transceiver station BTS is frequently monitored in each timeslot by the terminal

device TD (step S2). If necessary, i.e. when the signal strength changes above or below a predetermined value, in step S3, the terminal device TD requests an increase or decrease of the transmission power of the base transceiver station, respectively.

This request is represented by specific information elements or commands which are known as so-called transfer power control bits TPC. Said TPC bits have a value of +1 if an increase of power by a predetermined level is requested and a value of -1 if a decrease of power by a predetermined level is requested. For each time unit, one TPC bit is sent. Said time unit is for example one timeslot or a frame consisting of a plurality of timeslots.

In step S4, the base transceiver station BTS receives said TPC bits sent for each time unit. Furthermore, a predetermined number w of said TPC bits, i.e. TPC bits of a predetermined number w of subsequent time units are stored. When reaching the predetermined number w, in step S5, a power raise during the recent w time units is calculated. This power raise can be determined for example by summing the TPC bits. Then, in step S6, also an received average power of transmission (e.g. indicated in dB) is calculated during said w time units by using the TPC bits. The calculation of the average power can be performed, for example, as follows: In the beginning of a calculation period, the power (i.e. the signal strength) has an value of e.g. 10 dBm. When in the calculation period TPC bits -1, +1, +1, +1 are sent, the average power is calculated by

$$\text{average power} = ((10-1)+(10-1+1)+(10-1+1+1)+ +(10-1+1+1+1))/4 = 42/4 \text{ [dBm]}.$$

In step S7, it is decided by using said calculated power raise and average power of transmission during the w time units, whether the power raise is higher than a sum of the

average power and a predetermined level L. Said predetermined level L is given for example in dB.

If the decision in step S7 is positive, i.e. the power raise for said w time units is at least L dB higher than the average power, a increase of the transmission power is inhibited (step S8). That means, the transmission power used by the base transceiver station BTS to the terminal device TD is kept constant or is even decreased, even if an increase was requested.

On the other hand, if the decision in step S7 is negative, i.e. the power raise during said w time units is not L dB higher than the average power, a power raise is allowed, i.e. the transmission power can be increased (or decreased) by the base transceiver station (step S9) as requested. The transmission power sent by the base transceiver station is increased (or decreased) according to the sum of all TPC bits received during all w time units (e.g. +3). Optionally, the transmission power may only be increased (or decreased) according to the most recent requested power raise (i.e. only the last received TPC bit, for example +1, is taken into account). The decision, in which way of the above described cases the power is changed, may be depending on the respective application.

In step S10, the power control method is restarted.

With reference to FIG. 2, a device adapted to perform a power control method according to the present invention is described below.

When the communication between terminal devices TD via at least one base transceiver station BTS (and probably other network elements) starts, the received signal strength (i.e. the transmission power used for the communication) is

monitored frequently and periodically at each time unit by a monitoring means 10. A requesting means 20 requests an increase or a decrease of the transmission power used by the base transceiver station BTS depending on results of said monitoring means 10. For this purpose a TPC bit having a value of +1 or -1 is sent each timeslot as command data from the terminal device TD to the base transceiver station BTS.

Said TPC bits are received by a receiving means 30, for example at the base transceiver station, to be stored in a storing means 40. Said storing means 40 is adapted to store at least a predetermined number w of TPC bits (TPC bits of w time units or timeslots). When the predetermined number w of TPC bits is reached, a calculating means 50 calculates the power raise and the average power using the stored TPC bits during said w time units as described above.

In a deciding means 60 it is decided whether the calculated power raise is greater than the sum of the average power and the predetermined level L.

Depending on the result of said deciding means 60 an output means 70 outputs a power change signal which inhibit a transmission power change by the base transceiver station BTS in the case that the power raise is at least L dB higher than the average power. On the other hand, in the case that the power raise is not L dB higher than the average power, a power change signal is output to allow a increase (or decrease) of power by the base transceiver station BTS as requested.

A proposal for parameters w and L are w = 16 ... 64 and L = 1 dB ... 3 dB. However, other parameter values can be used depending on for example user specific or connection type specific specifications.

By using the above described downlink power control it is possible to reach of several dB in comparison to the conventional power control. The reached gain depends also on the connection type, e.g. outdoor to indoor channel, single path channel etc. In case that there are only few multipaths, the gain is the highest. It is possible to reach a 20% gain in capacity in comparison to the previous known methods in the system level.

As a second embodiment, the above described method and device can also be used in uplink direction, i.e. in power control for signaling from the terminal device TD to the base transceiver station BTS. In this case, the signal strength from the terminal device TD is monitored by the base transceiver station. The further steps of storing, calculating, comparing/deciding and outputting (steps S4 to S9) and the corresponding means 30 to 70 may then be implemented also in the base transceiver station BTS or in the terminal device TD. In case of the uplink power control, the method for example is based on received signal to interference ratio (SIR) values which represent the difference between a „wanted" signal and an interfering signal.

It is to be noted that the present invention can be implemented as hardware and/or software in the terminal device and/or the base transceiver station. The present invention can be used preferably in WCDMA systems during a packet data communication, but also in any other CDMA system (for example IS-95, cdma2000 etc.) during any data communication (speech, packet data and the like).

Furthermore, the calculation (and therefore the decision whether to allow or to prevent a power raise) can be done timeslot per timeslot. Alternatively, it is also possible

to use more timeslots or time units (i.e. TPC bits) for the calculation of the power raise and the average power.

The present invention proposes a method for controlling a power used for transmitting data between a terminal device TD and a transceiver device BTS of a communication system, said method comprising the steps of monitoring S2 during a predetermined time unit the power used in a transmission between said terminal device TD and said transceiver device BTS, requesting S3 an increase or a decrease of the power used in the transmission by using a specific information element TPC for each predetermined time unit, storing S4 a predetermined number w of said specific information elements TPC, calculating S5, S6 a first value and a second value concerning the power of transmission during said predetermined number w of said specific information elements TPC, and deciding S7 by using the first value and the second value concerning the power calculated in said calculating step S5, S6, whether the first value concerning the power is greater than a sum of the second value concerning the power and a predetermined level L. The present invention also proposes a corresponding device.

It should be understood that the above description and accompanying figures are merely intended to illustrate the present invention by way of example only. The preferred embodiments of the present invention may thus vary within the scope of the attached claims.

CLAIMS

1. A method for controlling a power used for transmitting data between a terminal device (TD) and a transceiver device (BTS) of a communication system, said method comprising the steps of:

monitoring (S2) during a predetermined time unit the power used in a transmission between said terminal device (TD) and said transceiver device (BTS),

requesting (S3) an increase or a decrease of the power used in the transmission by using a specific information element (TPC) for each predetermined time unit,

storing (S4) a predetermined number (w) of said specific information elements (TPC),

calculating (S5, S6) a first value and a second value concerning the power of transmission during said predetermined number (w) of said specific information elements (TPC), and

deciding (S7) by using the first value and the second value concerning the power calculated in said calculating step (S5, S6), whether the first value concerning the power is greater than a sum of the second value concerning the power and a predetermined level (L).

2. A method according to claim 1, wherein said predetermined time unit is a timeslot.

3. A method according to claim 1, wherein said predetermined time unit is a frame composed of a plurality of timeslots.

4. A method according to claim 1, wherein each one of said specific information elements (TPC) used in each predetermined time unit is either -1 indicating a request

for a decrease of power or +1 indicating a request for an increase of power.

5. A method according to claim 1, wherein said first value concerning the power represents a power raise for said predetermined number (w) of said specific information elements (TPC) and said second value concerning the power is an average power for said predetermined number (w) of said specific information elements (TPC).

6. A method according to claim 5, further comprising the steps of:

if the decision in said deciding step (S7) is positive, inhibiting (S8) a power raise due to a request for increase the power in said requesting step (S3), and

if the decision in said deciding step (S7) is negative, allowing (S9) a power raise due to a request for increase the power in said requesting step (S3).

7. A method according to claim 1 to 6, wherein said method is performed by at least one of said terminal device (TD) and said transceiver station (BTS).

8. A method according to claim 1 to 6, wherein said method is performed in downlink direction.

9. A method according to claim 1 to 6, wherein said method is performed in uplink direction.

10. A device for controlling a power used for transmitting data between a terminal device (TD) and a transceiver device (BTS) of a communication system, said device comprising:

monitoring means (10) for monitoring during a predetermined time unit the power used in a transmission

between said terminal device (TD) and said transceiver device (BTS),

requesting means (20) for requesting an increase or a decrease of the power used in the transmission by using a specific information element (TPC) for each predetermined time unit,

storing means (40) for storing a predetermined number (w) of said specific information elements (TPC),

calculating means (50) for calculating a first value and a second value concerning the power of transmission during said predetermined number (w) of said specific information elements (TPC), and

deciding means (60) for deciding (S7) by using the first value and the second value concerning the power calculated by said calculating means (50), whether the first value concerning the power is greater than a sum of the second value concerning the power and a predetermined level (L).

11. A device according to claim 10, wherein said predetermined time unit is a timeslot.

12. A device according to claim 10, wherein said predetermined time unit is a frame composed of a plurality of timeslots.

13. A device according to claim 10, wherein each one of said specific information elements (TPC) used in each predetermined time unit is either -1 indicating a request for a decrease of power or +1 indicating a request for an increase of power.

14. A device according to claim 10, wherein said first value concerning the power is a power raise for said predetermined number (w) of said specific information elements (TPC) and said second value concerning the power

is an average power for said predetermined number (w) of said specific information elements (TPC).

15. A device according to claim 10, further comprising an output means (70) for outputting a signal adapted to inhibit a power raise due to a request for increase the power made by said requesting means (20) if said deciding means (60) decides that the first value concerning the power is greater than the sum of the second value concerning the power and the predetermined level (L), or allow a power raise due to a request for increase the power made by said requesting means (20) if said comparing means (60) decides that the first value concerning the power is not greater than the sum of the second value concerning the power and the predetermined level (L).

16. A device according to claim 10 to 15, wherein said device is included by at least one of said terminal device (TD) and said transceiver station (BTS).

17. A device according to claim 10 to 15, wherein said device is adapted to perform a power control in downlink direction.

18. A device according to claim 10 to 15, wherein said device is adapted to perform a power control in uplink direction.

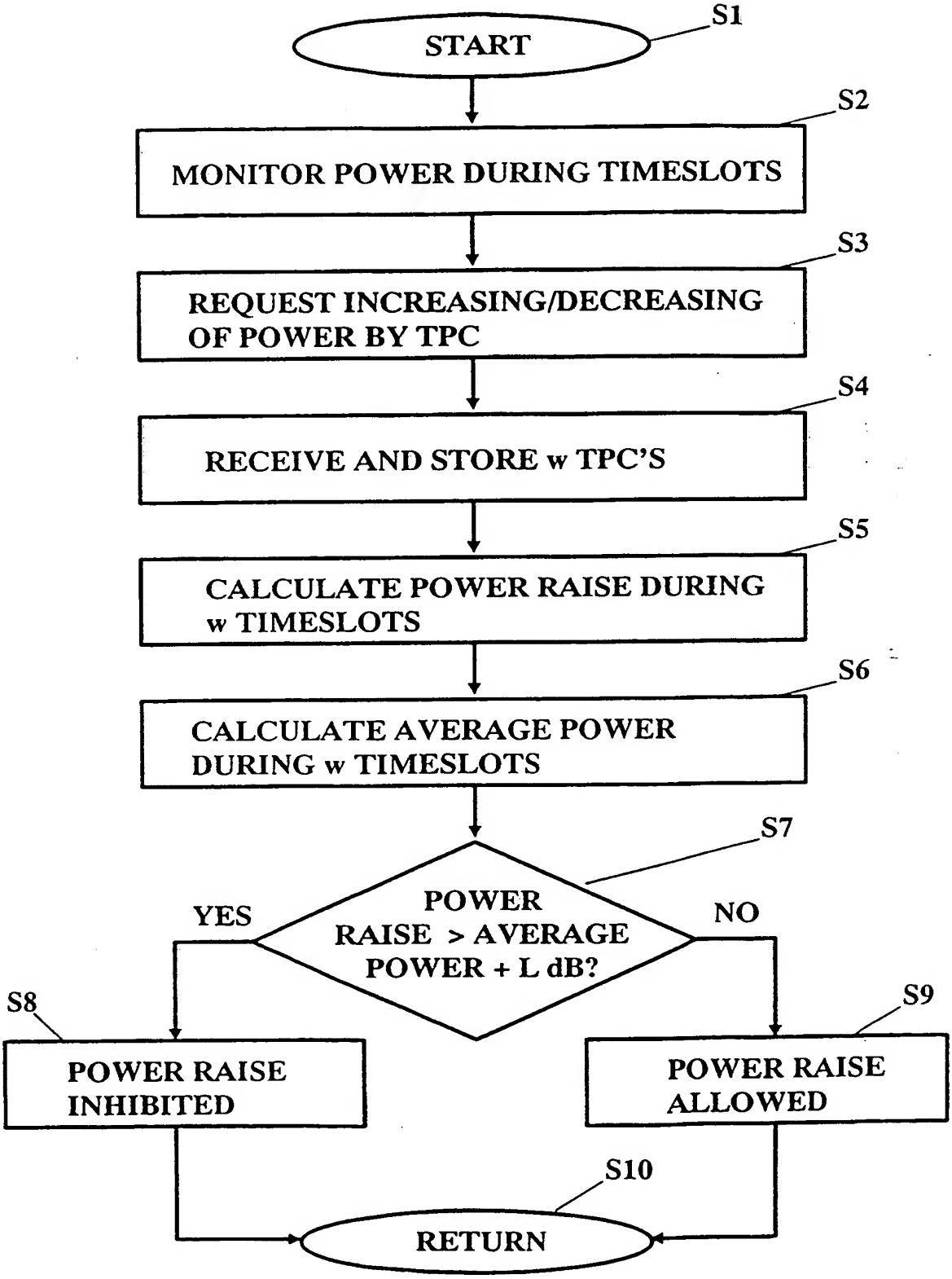
START
S1
MONITOR POWER DURING TIMESLOTS
S2
REQUEST INCREASING/DECREASING OF POWER BY TPC
S3
RECEIVE AND STORE w TPC'S
S4
CALCULATE POWER RAISE DURING w TIMESLOTS
S5
CALCULATE AVERAGE POWER DURING w TIMESLOTS
S6
POWER RAISE > AVERAGE POWER + L dB?
S7
YES
NO
POWER RAISE INHIBITED
S8
POWER RAISE ALLOWED
S9
RETURN
S10

FIG. 1

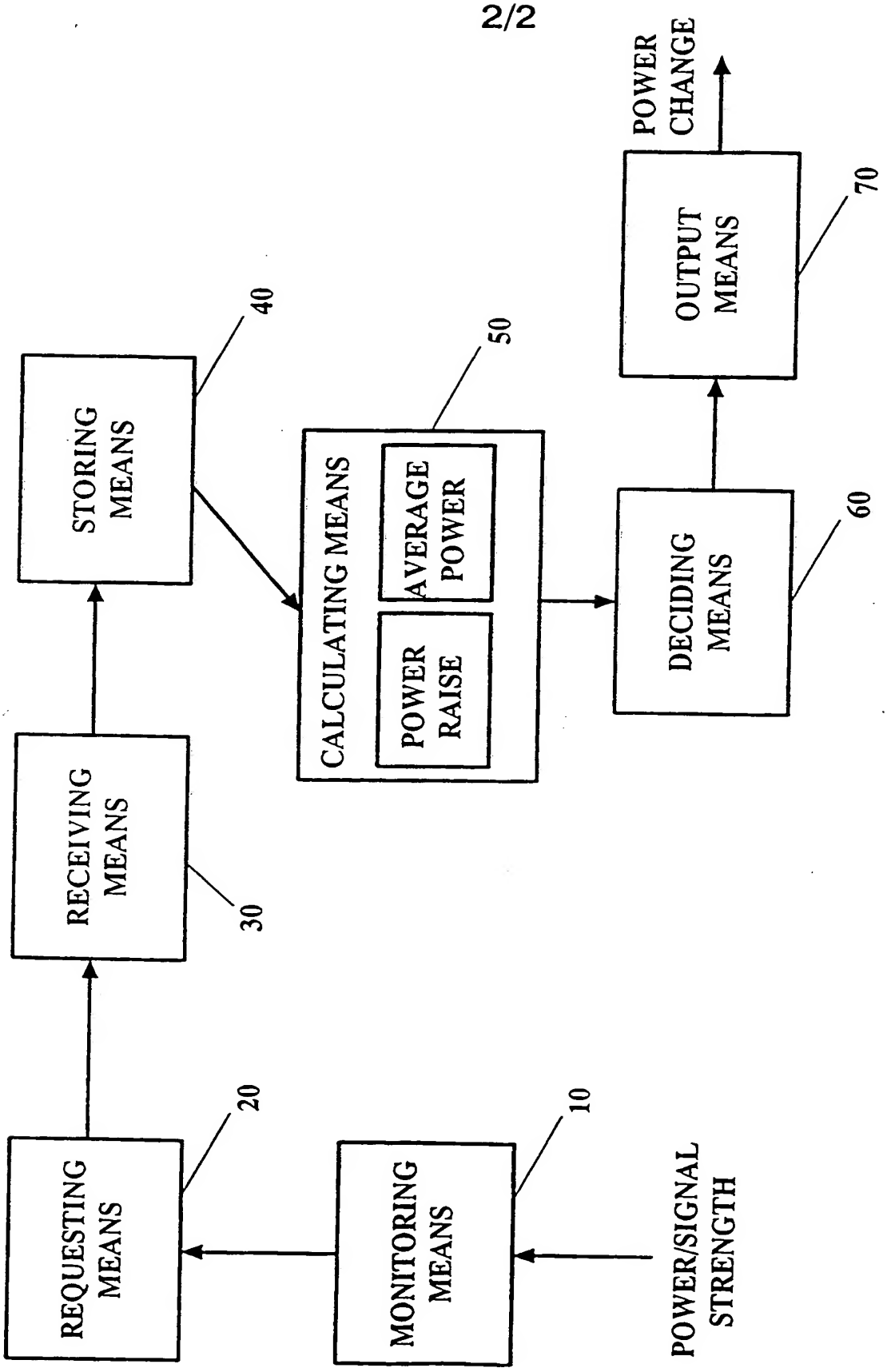
POWER/SIGNAL STRENGTH
MONITORING MEANS
10
REQUESTING MEANS
20
RECEIVING MEANS
30
STORING MEANS
40
CALCULATING MEANS
50
POWER RAISE
AVERAGE POWER
DECIDING MEANS
60
OUTPUT MEANS
70
POWER CHANGE

FIG. 2

INTERNATIONAL SEARCH REPORT

Int[redacted] Application No
PCT/EP 99/04495

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B7/005

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 10 066139 A (SAMSUNG ELECTRON CO LTD) 6 March 1998 (1998-03-06) & US 6 002 942 A (PARK HYUN-CHUL) 14 December 1999 (1999-12-14) column 1, line 31-48 column 2, line 4 -column 4, line 18 figures 1-3	1,4, 7-10,13, 16-18
Y	EP 0 682 417 A (NIPPON TELEGRAPH & TELEPHONE) 15 November 1995 (1995-11-15) page 3, line 21 -page 4, line 31 page 5; tables 1,2 figures 2A,2B,3,4A,4B	1,4, 7-10,13, 16-18

-/—

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 March 2000	06/04/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Yang, Y

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 682 419 A (NIPPON TELEGRAPH & TELEPHONE) 15 November 1995 (1995-11-15) column 4, line 37 -column 6, line 23 figures 4-6,7A,7B	1,3,7,9, 10,12, 16,18

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int[illegible] Application No
PCT/EP 99/04495

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		US 5590409 A	31-12-1996

However, in case of e.g. a packet data service, a retransmission protocol is included. This means that a loss of data, for example due to decoding problems, would not cause absolute errors but only lead to a retransmission. This allows a packet data power control not to follow every fade, but to compensate fades by retransmissions.

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Consequently, it is an object of the present invention to provide a method and a corresponding device for controlling a power used for transmitting data between a terminal device and a transceiver device of a communication system.

According to the present invention, this object is achieved by a method for controlling a power used for transmitting data between a terminal device and a transceiver device of a communication system, said method comprising the steps of monitoring during a predetermined time unit the power used in a transmission between said terminal device and said transceiver device, requesting an increase or a decrease of the power used in the transmission by using a specific information element for each predetermined time unit, storing a predetermined number of said specific information elements, calculating a first value and a second value concerning the power of transmission during said predetermined number of said specific information elements, and deciding by using the first value and the second value concerning the power calculated in said calculating step,

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.